

## **CHAPTER 8 – TRIP ASSIGNMENT**

### **INTRODUCTION**

This Chapter describes the various trip assignment methodologies and findings. Assignments used in the Year 2003 Model Validation include: a highway assignment to the street and highway network, a transit assignment to the transit network, a heavy-duty truck assignment integrated with the highway assignment for light-and-medium duty vehicles, and a toll assignment procedure to assign toll trips.

Highway assignment is the process of loading vehicle trips onto the appropriate highway network to produce traffic volumes, congested speeds, Vehicle Miles Traveled (VMT), and Vehicle Hours Traveled (VHT) estimates, for each of the four travel periods. Link or segment assignments by time period are added to produce average daily traffic volumes for the model network.

Highway assignment validation is one of the crucial steps in the modeling process. The ability for the model to produce current volume estimates within acceptable ranges of tolerance compared to actual ground counts is essential. The screenline analysis for the Year 2003 Model Validation run is presented in this Chapter. Also, key to assignment validation is the comparison of VMT estimated by the model, to estimates from the Highway Performance Monitoring System (HPMS). An acceptable tolerance level is mandatory for regional air quality planning and conformity purposes. Specifics regarding the comparative analysis are summarized in this Chapter and assignment statistics for the Region are also presented.

The SCAG Year 2003 Regional Transportation Model includes a complete Heavy-Duty Truck Model component, providing assignment results for heavy-duty trucks, as well as for light-and-medium duty vehicles. This Chapter presents the results of the truck traffic assignment combined with the results from the light-and-medium duty vehicle assignment. A description of the Heavy-Duty Truck Model is presented in Chapter 7.

This Chapter also briefly summarizes the results of the transit trip assignment. Transit trips are estimated by the mode choice model, and are assigned to transit routes to produce transit network loadings.

### **TIME OF DAY FACTORING**

In the highway assignment, vehicle trips for all trip purposes are assigned, or loaded, onto each of the four time period (am peak, mid-day, pm peak, and night) highway networks. Before this can be done, the trips in each of the vehicle trip tables in production-attraction format (except for other-other trips), from the mode choice model, must be converted to Origin-Destination (O-D) format by time of day. This conversion is accomplished using a set of trip-in-motion factors derived from SCAG's 2001 Household

Travel Survey. The time-of-day factors allocate the P & A formatted trips by trip purpose to each of the four time periods. Table 8-1 identifies the factors that were used in this process.

There are two sets of factors. The first is applied at the end of trip generation to subdivide trips by purpose into "peak" and "off-peak" subcategories for input into the trip distribution models. The second is applied prior to trip assignment to allocate peak trips into the A.M. and P.M. peak periods by direction of travel. It also allocates off-peak trips into midday and night-time periods by direction of travel. Both of these sets of factors are displayed in Table 8-1. Table 8-1 also includes similar factors used to subdivide and stratify internal-external and external-internal trips (trips from within the Region with destinations outside of the Region and vice-versa). The Truck Model has unique factors to manipulate truck trips into directional O-D trip tables for each of the four time periods. Once all of the factors are applied, O-D trip tables are summed for all trip purposes and then assigned by time period.

## **EXTERNAL TRIPS**

External trips (cordon trips) are trips with one or both ends outside the modeling area. External trips for the light-and-medium duty vehicles are estimated independently from heavy-duty vehicles (trucks). The following provides a brief description of the methodology used to estimate light-and-medium duty (auto) vehicle external trips. The external trip methodology used to develop truck cordon trips is described in the Heavy-Duty Truck Model Report.

Traffic counts were obtained for each cordon location to estimate Year 2003 cordon volumes. Previous cordon survey results were then used to split total external trips into: 1) through trips - External-to-External (E-E), and 2) External-to-Internal (E-I) and Internal-to-External (I-E). The resulting through trip table (E-E) and the I-E/E-I trip table were combined with trip tables from previous steps to form final O-D vehicle trip tables for highway assignment.

Table 8-1

YEAR 2003 VEHICLE TRIPS-IN-MOTION FACTORS			
HOME-BASED WORK DIRECT TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	29.92	0.93	30.85
PM Peak (3pm - 7pm)	2.24	33.44	35.68
<b>"Peak"</b>	<b>32.16</b>	<b>34.37</b>	<b>66.53</b>
Midday (9am - 3pm)	9.21	6.10	15.30
Night (19pm - 6am)	8.52	9.64	18.16
<b>"Off-Peak"</b>	<b>17.73</b>	<b>15.73</b>	<b>33.47</b>
<b>TOTAL</b>	<b>49.90</b>	<b>50.10</b>	<b>100.00</b>
HOME-BASED WORK STRATEGIC TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	18.63	0.54	19.18
PM Peak (3pm - 7pm)	2.20	29.17	31.37
<b>"Peak"</b>	<b>20.83</b>	<b>29.72</b>	<b>50.55</b>
Midday (9am - 3pm)	26.41	9.39	35.81
Night (19pm - 6am)	2.76	10.89	13.65
<b>"Off-Peak"</b>	<b>29.17</b>	<b>20.28</b>	<b>49.45</b>
<b>TOTAL</b>	<b>50.00</b>	<b>50.00</b>	<b>100.00</b>
HOME-BASED COLLEGE TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	24.73	0.62	25.35
PM Peak (3pm - 7pm)	9.43	16.82	26.24
<b>"Peak"</b>	<b>34.16</b>	<b>17.44</b>	<b>51.59</b>
Midday (9am - 3pm)	16.59	15.17	31.76
Night (19pm - 6am)	1.00	15.64	16.64
<b>"Off-Peak"</b>	<b>17.59</b>	<b>30.81</b>	<b>48.41</b>
<b>TOTAL</b>	<b>51.75</b>	<b>48.25</b>	<b>100.00</b>
HOME-BASED SCHOOL TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	50.28	0.00	50.28
PM Peak (3pm - 7pm)	0.72	22.08	22.80
<b>"Peak"</b>	<b>50.99</b>	<b>22.08</b>	<b>73.07</b>
Midday (9am - 3pm)	2.41	22.68	25.08
Night (19pm - 6am)	0.59	1.25	1.84
<b>"Off-Peak"</b>	<b>3.00</b>	<b>23.93</b>	<b>26.93</b>
<b>TOTAL</b>	<b>53.99</b>	<b>46.01</b>	<b>100.00</b>
HOME-BASED SHOPPING TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	5.16	1.14	6.30
PM Peak (3pm - 7pm)	9.82	25.11	34.93
<b>"Peak"</b>	<b>14.98</b>	<b>26.25</b>	<b>41.23</b>
Midday (9am - 3pm)	21.01	20.60	41.61
Night (19pm - 6am)	5.18	11.97	17.15
<b>"Off-Peak"</b>	<b>26.19</b>	<b>32.57</b>	<b>58.76</b>
<b>TOTAL</b>	<b>41.17</b>	<b>58.82</b>	<b>99.99</b>
HOME-BASED OTHER TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	9.48	1.11	10.59
PM Peak (3pm - 7pm)	11.81	16.51	28.32
<b>"Peak"</b>	<b>21.29</b>	<b>17.62</b>	<b>38.91</b>
Midday (9am - 3pm)	21.63	14.37	36.00
Night (19pm - 6am)	6.65	18.44	25.10
<b>"Off-Peak"</b>	<b>28.28</b>	<b>32.81</b>	<b>61.09</b>
<b>TOTAL</b>	<b>49.57</b>	<b>50.43</b>	<b>100.00</b>
HOME-BASED SERVING PASSENGER TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	23.79	9.06	32.85
PM Peak (3pm - 7pm)	10.98	20.76	31.74
<b>"Peak"</b>	<b>34.77</b>	<b>29.82</b>	<b>64.59</b>
Midday (9am - 3pm)	13.74	10.49	24.23
Night (19pm - 6am)	4.00	7.18	11.18
<b>"Off-Peak"</b>	<b>17.74</b>	<b>17.67</b>	<b>35.41</b>
<b>TOTAL</b>	<b>52.51</b>	<b>47.49</b>	<b>100.00</b>
WORK-BASED OTHER TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	2.88	14.72	17.60
PM Peak (3pm - 7pm)	34.34	2.81	37.15
<b>"Peak"</b>	<b>37.22</b>	<b>17.53</b>	<b>54.75</b>
Midday (9am - 3pm)	27.33	12.01	39.34
Night (19pm - 6am)	3.77	2.14	5.91
<b>"Off-Peak"</b>	<b>31.10</b>	<b>14.15</b>	<b>45.25</b>
<b>TOTAL</b>	<b>68.32</b>	<b>31.68</b>	<b>100.00</b>
OTHER-BASED OTHER TRIPS			
	P → A	A → P	Total
AM Peak (6am - 9am)	4.71	4.71	9.41
PM Peak (3pm - 7pm)	15.72	15.72	31.44
<b>"Peak"</b>	<b>20.42</b>	<b>20.42</b>	<b>40.85</b>
Midday (9am - 3pm)	23.88	23.88	47.75
Night (19pm - 6am)	5.70	5.70	11.40
<b>"Off-Peak"</b>	<b>29.58</b>	<b>29.58</b>	<b>59.15</b>
<b>TOTAL</b>	<b>50.00</b>	<b>50.00</b>	<b>100.00</b>

## **DESCRIPTION OF HIGHWAY ASSIGNMENT PROCEDURES**

Vehicle trip assignment is the process of loading vehicle trips onto the appropriate highway network. This process produces traffic volumes and resulting congested speeds on each road segment represented in the network for the four time period. The Year 2003 Model Validation model runs consist of series of multi-class simultaneous equilibrium assignments for six classes of vehicles (drive alone, 2-person carpool, 3+ person carpool, light HDT, medium HDT, and heavy HDT) and for each of the four time periods. During this assignment process, trucks are converted to PCE for each link based on 1) percentage of trucks, 2) percentage of grade, 3) length of the link, and 4) level of congestion (v/c ratios). Transit vehicles are also included in the highway assignment.

To achieve convergence of model results, a 5-loop feedback procedure was incorporated in the Year 2003 model. The following is a brief description of the process:

- Step 1: The trip generation, trip distribution, and the mode choice models were run using the initial speeds coded on the input highway networks to develop the initial AM peak period and mid-day period trip tables. This set of initial trip tables for each time period and for each vehicle class was assigned to the corresponding highway networks. This process produced the first pass (loop) highway assignments and yielded model-estimated congested speeds for the highway networks.
- Step 2: The congested speeds were then fed back into the trip generation, trip distribution, and mode choice models to produce a second set of congested speeds for the AM and mid-day highway networks. An averaging process was utilized to smooth the volume variation between the first pass (loop) of the trip assignment and the second pass of the trip assignment step. A new set of congested speeds was then created and fed to trip generation, trip distribution, and mode choice models to produce a new set of trip tables for the third pass of trip assignment. This process was repeated one more time to produce a set of reasonably converged AM peak and mid-day networks.
- Step 3: The new set of congested speeds were then fed back into the trip generation, trip distribution, and mode choice models to produce trip tables for assignments for each scenario. The final assignment of trips was performed for all four time periods (AM, mid-day, PM, and night period).

## **HIGHWAY ASSIGNMENT SUMMARY**

Table 8-2 presents an overview of the highway assignment statistics for each model time period and daily total. The Regional Transportation Model forecasts 371,973,000 VMT on an average weekday in Year 2003 within the expanded model area for both light and medium duty vehicles. In addition, the Regional Model forecasts 29,524,000 VMT for

heavy-duty vehicles in the expanded model area. The total for all vehicle types combined is 401,497,000 VMT.

Travel summaries have been compiled to report VMT, VHT, and vehicle hours of delay by county, facility type, and air basin. Table 8-3 presents VMT comparisons of the SCAG-modeled VMT to VMT estimates from the HPMS by county and by air basin. The results for total VMT are very consistent. Specifically, the L&M VMT results within the South Coast Air Basin are 2.7 percent below the corresponding results derived from HPMS data for all vehicles. Further, the L&M VMT results from the Ventura County portion of the SCAG modeling area are within 6.5 percent of the corresponding HPMS statistical data.

Vehicle trip assignment is validated by comparing modeled total daily traffic volumes to actual Average Daily Traffic (ADT) counts or "ground counts", across a set of screenlines. A screenline is an imaginary line drawn across the highway network at strategic locations in the modeling area, which capture the total traffic flow across that line.

For the Year 2003 Model Validation, the highway assignments were validated using a screenline analysis performed on 23 regional screenlines, including three new screenlines in developing areas. The screenline locations are depicted in Figure 8-1, and the results are presented in Table 8-4. Overall, the model volumes across all screenlines combined, differed by less than 1.5 percent from the same total of the "observed" or ground counts. On an individual screenline basis, of the 23 screenlines, 10 came within 5 percent of the "observed" count, 6 came within 5-10 percent, 4 came within 10-15 percent, and the remaining 3 screenlines fell within 15-18 percent of the count. These results are within tolerance levels considered acceptable for regional transportation modeling.

Figure 8-2 presents a scatter plot of screenline directional link volumes between 2003 model volumes and actual traffic counts. Overall the model shows good fit with ground counts. Regression R-square value is 0.932, and the RMSE is 29.42. The comparison of model speed with PeMS speed data is presented in Figures 8-3 through 8-6.

Table 8-2

YEAR 2003 HIGHWAY ASSIGNMENT STATISTICS BY TIME PERIOD					
Light and Medium Duty Vehicles	AM PEAK	PM PEAK	MIDDAY	NIGHT	TOTAL
Average Speed (mph)	30.9	26.6	35.2	43.1	31.7
Vehicle Miles Traveled (`000)	77,515	128,557	108,137	57,765	371,973
Vehicle Hours Traveled (`000)	2,508	4,826	3,075	1,341	11,751
Vehicle Hours Delay (`000)	723	1,778	583	82	3,167
Heavy Duty Vehicles	AM PEAK	PM PEAK	MIDDAY	NIGHT	TOTAL
Average Speed (mph)	35.7	31.0	40.5	52.4	40.0
Vehicle Miles Traveled (`000)	3,833	6,266	10,322	9,103	29,524
Vehicle Hours Traveled (`000)	107	202	255	174	739
Vehicle Hours Delay (`000)	33	79	56	12	180
All Vehicles Combined	AM PEAK	PM PEAK	MIDDAY	NIGHT	TOTAL
Average Speed (mph)	31.1	26.8	35.6	44.1	32.1
Vehicle Miles Traveled (`000)	81,347	134,823	118,459	66,868	401,497
Vehicle Hours Traveled (`000)	2,616	5,028	3,330	1,515	12,490
Vehicle Hours Delay (`000)	756	1,857	639	94	3,346

Table 8-3

## YEAR 2003 VMT COMPARISON BY COUNTY AND BY AIR BASIN (IN THOUSANDS)

COUNTY		VC SCCAB		SCAB		MDAB		SSAB		TOTAL		COUNTY TOTAL
		Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck	Auto	Truck	
IMPERIAL	Model HPMS	-	-	-	-	-	-	4,343	737	4,343	737	5,080
		-	-	-	-	-	-	4,335	607	4,335	607	4,941
LOS ANGELES	Model HPMS	-	-	185,519	13,064	6,114	408	-	-	191,633	13,471	205,104
		-	-	197,363	11,656	7,268	389	-	-	204,631	12,045	216,676
ORANGE	Model HPMS	-	-	65,391	3,573	-	-	-	-	65,391	3,573	68,964
		-	-	66,509	3,774	-	-	-	-	66,509	3,774	70,283
RIVERSIDE	Model HPMS	-	-	35,553	2,842	1,626	692	8,175	1,396	45,355	4,931	50,285
		-	-	28,577	2,516	1,484	520	9,288	1,469	39,349	4,505	43,854
SAN BERNARDINO	Model HPMS	-	-	28,544	2,067	20,424	3,728	-	-	48,968	5,795	54,763
		-	-	31,191	3,159	17,094	2,809	-	-	48,285	5,968	54,253
VENTURA	Model HPMS	16,283	1,017	-	-	-	-	-	-	16,283	1,017	17,301
		17,414	1,214	-	-	-	-	-	-	17,414	1,214	18,627
TOTAL	Model HPMS	16,283	1,017	315,008	21,546	28,164	4,827	12,518	2,134	371,973	29,524	401,497
		17,414	1,214	323,641	21,105	25,845	3,717	13,622	2,076	380,522	28,112	408,634
	Ratio	0.935	0.838	0.973	1.021	1.090	1.299	0.919	1.028	0.978	1.050	0.983

Table 8-4

**YEAR 2003 SCREENLINE COMPARISON OF MODEL WEEKDAY ADT AND GROUND COUNTS**

Screenline	Location	Direction	Daily Vehicle Volumes			
			Model	Count	Ratio	RMSE
1	Ventura / Los Angeles	EW	1,478,103	1,475,361	1.002	18.25
2	Los Angeles	NS	2,567,037	2,468,539	1.040	21.65
3	Los Angeles	EW	1,307,292	1,462,303	0.894	36.31
4	Orange	NS	1,714,901	1,701,072	1.008	35.06
5	Los Angeles / Orange	NS	1,538,663	1,321,967	1.164	32.84
6	San Bernardino / Riverside	NS	1,024,777	994,195	1.031	52.85
7	San Bernardino	EW	738,172	786,550	0.938	45.34
8	Los Angeles / Orange	NS	1,187,848	1,220,265	0.973	16.92
9	San Bernardino / Riverside	NS	468,094	472,748	0.990	45.68
10	Ventura / Los Angeles	NS	449,082	434,119	1.034	34.53
11	Ventura	NS	263,868	235,150	1.122	32.50
12	Riverside	NS	176,362	164,486	1.072	47.77
13	San Bernardino	EW	206,378	174,994	1.179	60.64
14	Riverside	EW	269,766	253,920	1.062	25.48
15	Orange	NS	646,018	670,570	0.963	42.27
16	Los Angeles	EW	1,462,218	1,290,971	1.133	24.00
17	Los Angeles	NS	2,354,706	2,437,178	0.966	29.69
18	Los Angeles	EW	374,748	407,512	0.920	29.89
19	Los Angeles	EW	174,828	211,090	0.828	35.10
20	San Bernardino	EW	94,461	82,342	1.147	52.61
21	Riverside	EW	153,449	161,106	0.952	38.45
22	Riverside / Imperial	EW	21,473	19,698	1.090	24.51
23	Imperial	EW	44,408	41,930	1.059	34.93
Total			18,716,650	18,488,066	1.012	29.42

Table 8-5

**YEAR 2003 SCREENLINE COMPARISON OF MODEL WEEKDAY ADT AND GROUND COUNTS BY VOLUME GROUP**

	VOLUME GROUP BY FACILITY	OBS	DAILY VEHICLE VOLUMES			
			Model	Count	Ratio	RMSE
1	0 - 4,999	58	219,239	142,649	1.54	121.32
2	5,000 - 24,999	181	2,741,946	2,620,454	1.05	47.50
3	25,000 - 49,999	121	3,692,413	3,702,827	1.00	35.70
4	50,000 - 99,999	22	926,673	956,722	0.97	26.72
5	100,000 - 199,999	26	1,975,327	1,824,360	1.08	19.78
6	200,000 or More	110	9,161,052	9,241,054	0.99	18.39
Total		518	18,716,650	18,488,066	1.01	29.42

Note: RMSE - root mean square error, OBS - number of roadway facility in the group.

Table 8-6

**YEAR 2003 SCREENLINE COMPARISON OF MODEL WEEKDAY ADT AND GROUND COUNTS BY FACILITY TYPE**

	FACILITY TYPE	OBS	Daily Vehicle Volumes			
			Model	Count	Ratio	RMSE
1	Freeway	114	11,229,968	11,150,274	1.01	16.71
2	HOV	42	593,131	508,770	1.17	52.82
3	Major Arterial	156	4,516,902	4,257,202	1.06	38.39
4	Minor Arterial	155	2,121,198	2,296,827	0.92	47.41
5	Collector	48	229,492	251,217	0.91	64.41
6	Ramps	3	25,959	23,776	1.09	13.20
Total		518	18,716,650	18,488,066	1.01	29.42

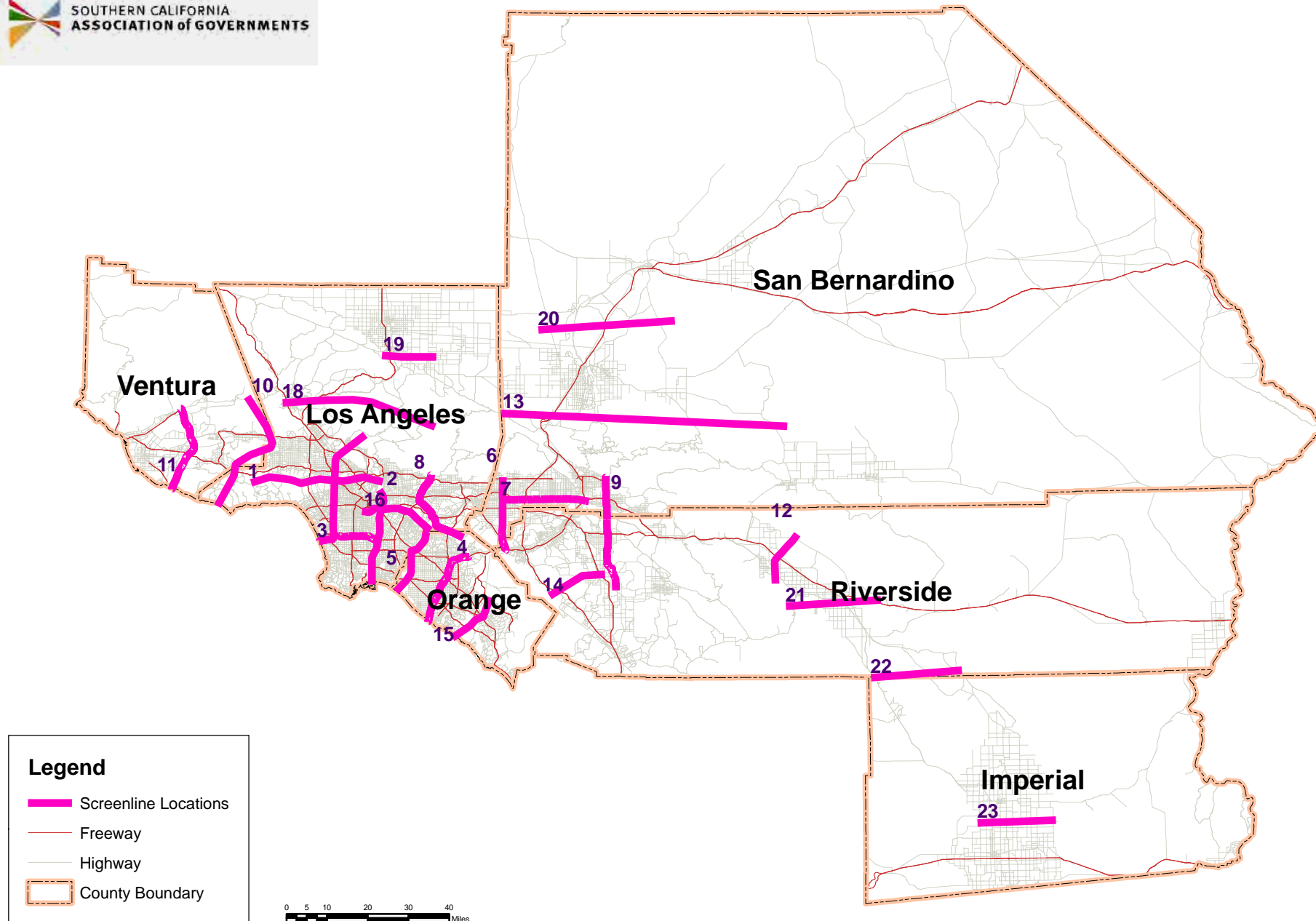
Note: RMSE - root mean square error, OBS - number of roadway facility in the group.

Table 8-7

**YEAR 2003 SCREENLINE COMPARISON OF MODEL WEEKDAY ADT AND GROUND COUNTS BY AREA TYPE**

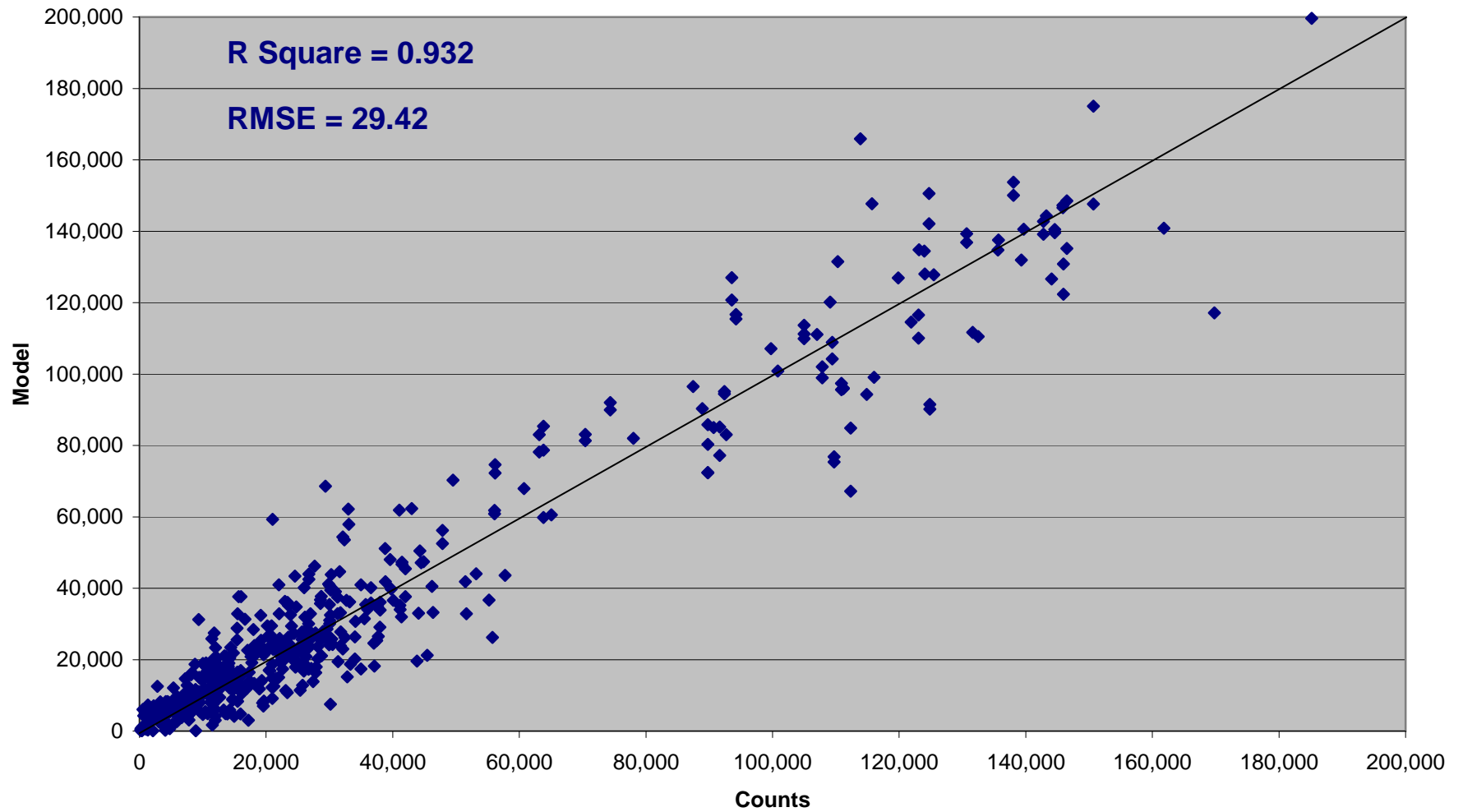
	AREA TYPE	OBS	Daily Vehicle Volumes			
			Model	Count	Ratio	RMSE
1	Core	0	-	-	-	-
2	Central Business District	3	71,260	74,509	0.96	18.27
3	Urban Business District	111	4,875,221	5,104,260	0.96	26.93
4	Urban	200	7,886,413	7,838,873	1.01	25.13
5	Suburban	143	4,689,205	4,319,296	1.09	34.36
6	Rural	50	951,662	943,472	1.01	52.02
7	Mountain	11	242,888	207,656	1.17	46.63
Total		518	18,716,650	18,488,066	1.01	29.42

Note: RMSE - root mean square error, OBS - number of roadway facility in the group.



**FIGURE 8-1**  
**REGIONAL SCREENLINE LOCATIONS**

**FIGURE 8-2**  
**YEAR 2003 SCREENLINE LINK VOLUMES**  
**(MODEL VS COUNTS)**



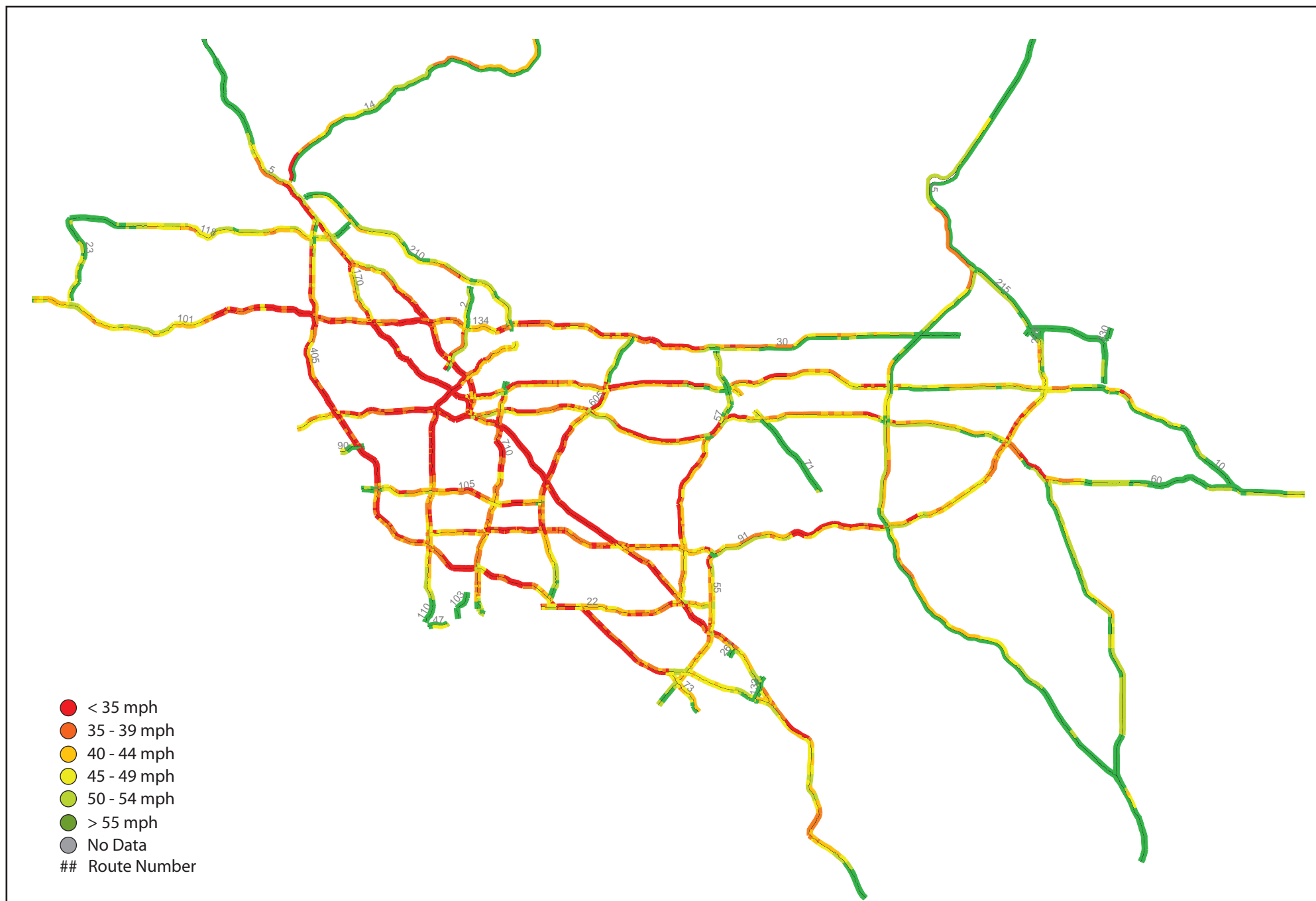


FIGURE 8-3  
YEAR 2003 AM PEAK PERIOD CONGESTED SPEED BY MODEL



FIGURE 8-4  
YEAR 2003 PM PEAK PERIOD CONGESTED SPEED BY MODEL



FIGURE 8-5

PEMS REAL TIME AM PEAK CONGESTED SPEED (8:30 a.m. on Wednesday, 03/21/2007)



## DESCRIPTION OF TRANSIT ASSIGNMENT PROCEDURES

The final transit trips from the last loop mode choice models are aggregated by access mode and time period, resulting in four transit trip tables (peak period auto access, peak period walk access, off-peak period auto access, and off-peak period walk access) for transit network assignment.

Each of these four trip tables is assigned separately to the peak and off-peak transit network. The resulting loaded transit network files are then aggregated to create a new loaded network containing total daily transit trips. The results of the transit assignment process are summarized below.

## TRANSIT ASSIGNMENT SUMMARY

The Year 2003 transit assignment loaded 2,185,927 unlinked passenger trips on the Year 2003 transit network. Table 8-8 presents the model estimated daily transit boardings for the four predominant transit mode categories, compared to actual transit boarding statistics for Year 2003. As Table 8-8 indicates the model estimates came within 4 percent of the actual regional total transit boardings. By mode category, the model came within 1 percent of the commuter rail boardings, 2 percent for the Metropolitan Transportation Authority (MTA) Bus boardings, and 2 percent for MTA Urban Rail boardings. The model's transit assignment over-estimated total boardings for non-MTA local transit services (other local transit operators within the Region) by approximately 8 percent.

Table 8-8

YEAR 2003 DAILY TRANSIT BOARDINGS - MODEL VS ACTUAL COUNTS			
TRANSIT MODE	MODEL ESTIMATED BOARDING	ACTUAL BOARDING	RATIO
Commuter Rail	34,612	34,600	1.00
Urban Rail	222,626	218,500	1.02
MTA Bus	1,118,573	1,095,800	1.02
Other Transit	810,116	749,900	1.08
Total Boardings	2,185,927	2,098,800	1.04